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(71) Applicant(s)

Mothercare UK Limited
(Incorporated in the United Kingdom)
Cherry Tree Road, WATFORD, Herts, WD2 5SH,
United Kingdom

John Heathcoat & Company Limited
(Incorporated in the United Kingdom)
Westex, TIVERTON, Devon, EX16 5LL,
United Kingdom

Relyon Limited
(Incorporated in the United Kingdom) P O Box 1,
Wellington, WELLINGTON, Somerset, TA21 8NN,
United Kingdom

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GB 2305191 A GB 2299814 A GB 2042003 A
WO 99/05990 A1 WO 96/01602 A1 WO 95/16416 A1
US 5896758 A US 5834382 A

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(72) Inventor(s)

John Campbell Anson
Brian Watterson
Richard Charles Marke

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(54) Abstract Title
Spacer fabric

(57) A flexible spacer fabric, suitable for a mattress cover has a liquid permeable and breathable upper surface layer, the upper surface layer comprising a knitted mesh wherein the ratio of average hole diameter to average strand width is from 4:1 to 1:2, a heat and liquid dissipating spacer layer, and a dimensionally stable lower surface layer. The fabric may be warp knitted. Wicking fibres may be used in the upper layer.

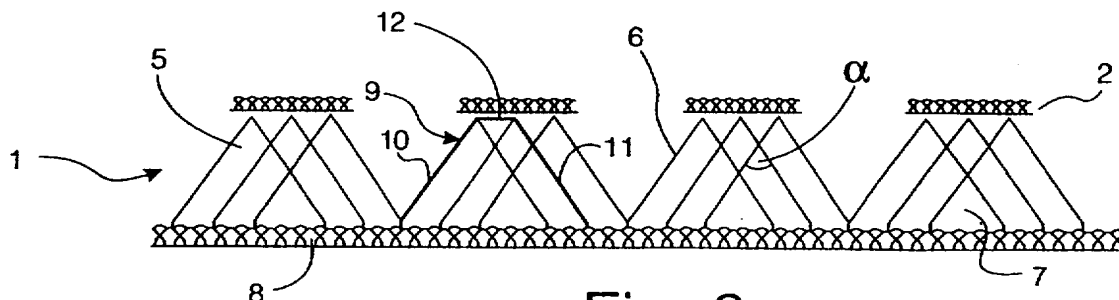


Fig. 2

(74) Agent and/or Address for Service

Harrison Goddard Foote

**Fountain Precinct, Leopold Street, SHEFFIELD, S1 2QD,
United Kingdom**

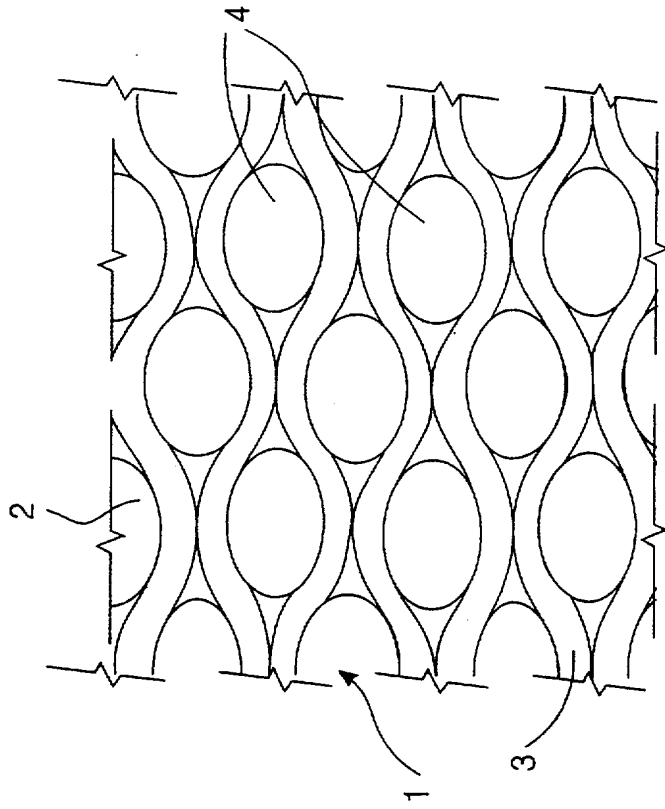


Fig. 1

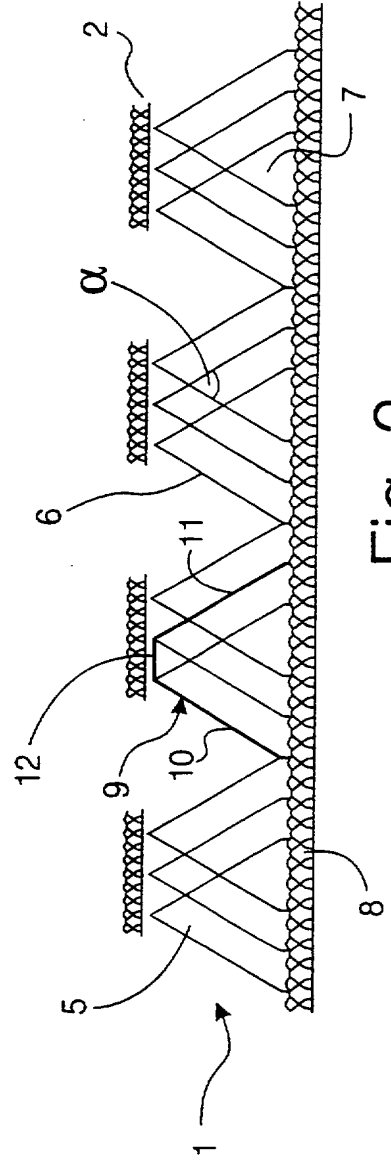


Fig. 2

IMPROVEMENTS IN OR RELATING TO SPACER FABRICS

This invention relates to spacer fabrics and more particularly to a novel spacer fabric and a mattress cover and composite mattress construction produced therefrom.

Spacer fabrics have opposite face structures united and held in spaced disposition by linking spacing threads. Spacer fabrics are known, for example, from GB2042003, which describes a liquid absorbing textile product, WO95/16416 which describes a compression bandage, WO95/12018 which describes clothing articles, US5896758 which describes a fabric for footwear and backpacks, WO99/05990 which describes a prosthetic fabric, WO96/01602 which describes a mat, and US5834382 which describes a high temperature resistant covering. The entire disclosure of all these patents are incorporated herein by reference for all purposes.

In UK Patent No.GB2305191B there is described and claimed a flexible spacer material, which comprises a fabric, providing a liquid permeable and breathable upper surface and a heat and liquid dissipating spacer layer, and a liquid impermeable lower surface layer. The spacer material is used for the production of mattress covers, and more particularly for cot mattresses for babies and young children. These are sold under the name SLEEPRIGHT (RTM) cot mattress by Mothercare Limited. The entire disclosure of GB2305191B is incorporated herein by reference for all purposes.

Whilst cot mattresses produced using the spacer materials described in GB2305191B have vastly improved properties

over conventional cot mattresses and the product has proved to be commercially extremely successful, certain improvements in the breathability and airflow properties of the spacer fabric would be very desirable.

5

Improved breathability obviously gives an improved safety factor for the cot mattress, and improved air flow reduces the risk of over-heating, thereby leading to even greater comfort for the infant.

10

According to the present invention, an improvement in breathability and air flow properties is obtained by increasing the ratio of hole size to strand size in the knitted mesh of the upper surface, the fabric, and/or by using only monofilament threads as linker threads in the spacer layer.

15

In a first aspect, the invention provides a flexible spacer fabric, the fabric having a liquid permeable and breathable upper surface layer, the upper surface layer comprising a knitted mesh wherein the ratio of average hole diameter to average strand width is from 4:1 to 1:2, a heat and liquid dissipating spacer layer, and a dimensionally stable lower surface layer.

25

In a further aspect, the invention provides a mattress cover material which comprises a flexible spacer fabric according to the invention and a liquid permeable lower surface layer.

30

In another aspect the invention provides a cot mattress comprising a foam plastics core or a spring mattress core and a cover comprising a flexible spacer fabric according to the invention and a liquid impermeable lower surface

layer.

In a still further aspect, the invention provides a cot mattress comprising a foam plastics core or a spring
5 mattress core, a cover comprising a flexible spacer fabric according to the invention, and, arranged between the mattress core and the cover, a liquid impermeable layer.

10 Preferred fibres for use in the upper surface layer are multifilament synthetic yarns. Suitable synthetic fibres include polyesters and polyamides, although polyesters are preferred, due to their greater heat stability. Preferred multi-filament yarns have a dTex of from 40 to
15 340, more preferably from 40 to 180.

The upper surface layer is preferably such that liquids and air can easily pass there through and into the spacer layer and the spacer fabric is preferably such that it
20 has an enhanced ability to conduct liquid away from the surface and dissipate it through the fabric structure, and such that it permits passage of air through the structure.

25 The upper surface layer is preferably a warp knitted mesh, having holes of a size such that liquids can pass therethrough. Preferably the holes are hexagonal, so that the upper surface layer has the appearance of a honeycomb.

30 The mesh hole size of the upper surface layer is preferably as large as possible for drainage and ventilation purposes, but should not be so large as to cause discomfort when placed next to the skin. A mesh

average hole diameter of from 1 to 3mm, preferably around 2mm has been found to give particularly good results.

5 The average width of the mesh strands in the upper surface layer is preferably from 0.1 to 4 mm, more preferably from 0.5 to 3mm, such as, for example, about 2 mm.

10 Preferably the ratio of the average hole diameter to the average width of the mesh strands in the upper surface layer is from 3:1 to 1:2, for example, 1:1.

15 Preferably the upper surface layer of the spacer fabric is such that liquids of viscosity of at least 20 dynes per centimetre and more preferably of at least 30 dynes per centimetre can pass through the upper surface and into the spacer layer without lying on the surface. Preferably the upper surface of the spacer fabric has a grade of less than 1 when tested in accordance with the
20 Oil Repellency Rating AATCC method.

The breathability of the upper surface layer is preferably such that, when placed face down on the fabric, a baby can continue to breath relatively
25 normally.

A suitable air permeability test providing a measure of the breathability of a fabric, i.e. the ease with which air passes through the fabric structure, is BS 4578:1970
30 (1991) Measurement of Restriction of Airflow. Preferably the spacer fabric has a value of less than 5 mm H₂O, more preferably less than 2.0mm H₂O, most preferably less than 1mm H₂O, when tested in accordance with BS 4578:1970 (1991).

Preferably the upper surface layer comprises a warp knitted mesh of multifilament yarns.

5 Increasing the ratio of average hole diameter to average strand width in the upper surface layer of the fabric can have the effect of lowering the wicking rate of the fabric. It has been found that this effect can be counterbalanced, at least to a significant degree, by
10 incorporating in the upper surface layer inherently wicking fibres or a wicking fibre construction.

Whilst the spacer fabric of GB2305191B undoubtedly has wicking properties, the upper surface layer is not stated
15 to have wicking properties independent of the fabric structure.

In this specification the term "wicking fibre" is intended to mean a fibre which, by virtue of its shape and configuration, and/or filament dTex, has inherent
20 wicking properties, whereby liquid can be transported along the fibre by capillary action. Similarly the term "wicking construction" is intended to mean a fibre construction, comprising two or more fibres, which
25 construction has inherent wicking properties, whereby liquid can be transported along the fibre construction by capillary action.

Preferred wicking fibres for use in the upper surface
30 layer are multifilament synthetic fibre yarns sold for their inherent wickability. Such fibres have enhanced capillary action by virtue of their shape and configuration. The enhanced wicking properties of so-called wicking fibres can be achieved, for example, by

various different fibre cross-sectional structures, preferably providing at least one longitudinal channel which permit faster liquid transport by capillary action. All wicking fibres will have a capability of wicking at a significantly greater rate and to a greater distance than conventional multifilament fibres of similar dTex. They can, for example, have a complex cross-section which provides a plurality of longitudinal channels to conduct liquid along the fibre at a rate and distance greater than a comparable conventional multifilament fibre with a circular cross-section. Fabrics knitted from inherently wicking fibres can have a drying rate of up to 20%, more preferably 30% and most preferably 50% faster than cotton, and up to 5%, and more preferably 10%, faster than conventional synthetic fibres. Preferably a fabric made from an inherently wicking fibre has a moisture loss of at least 5%, more preferably at least 10%, greater than a fabric made from a conventional synthetic fibre having a circular cross-section after 30 minutes.

Suitable synthetic fibre yarns include polyesters and polyamides, although polyesters are preferred, due to their greater heat stability. Preferred multi-filament yarns have a dTex of from 40 to 340, more preferably from 40 to 180. An example of a suitable wicking fibre is CoolMax™, which is a four channel Dacron™ polyester fibre with a special cross-sectional structure comprising three intersecting circles manufactured by Du Pont. Another potentially suitable wicking fibre is CoolMax Alta™, also manufactured by Du Pont.

Wicking fibre constructions which can be used in the upper surface layer usually comprise two or more synthetic fibres of different dTex, knitted in layers. A
5 typical wicking fibre construction comprises an upper layer of a relatively coarse fibre and a lower layer of a relatively fine fibre or microfilament.

Suitable synthetic fibres for the wicking fibre
10 construction include polyesters and polyamides, although polyesters are preferred due to their greater heat stability. The wicking fibre construction can, for example, comprises an upper layer of a coarse multifilament yarn having a filament dTex of from 6 to 3,
15 and a lower layer of a microfilament yarn having a dTex of from 1.1 to 0.3.

In addition to its inherent wicking properties, the upper surface layer can also aid liquid transport by allowing
20 liquids to pass through itself into the spacer layer.

In certain embodiments of the invention, at least the upper surface layer of the spacer fabric can also comprise an anti-bacterial yarn which is preferably of
25 the type which also retards the growth of mould, mildew and fungus. Incorporation of an inlay the anti-bacterial yarn can provide a safer and more hygienic spacer fabric. Other inlays which can be used include, for example, thermoregulating fibres.

30 The linking threads of the spacer layer preferably comprise a mono-filament yarn which traverses back and forth between the upper and lower surfaces. It has been found that, by omitting multi-filament linker threads

from the spacer layer, the air volume of the spacer layer can be increased, providing improved air permeability and heat dissipation. Omitting multi-filament linker threads makes possible for example, a 50% reduction in the number of threads linking across the spacer layer, compared to the commercially available product. In a preferred spacer fabric of the invention, the number of mono-filament linker threads in the spacer layer is preferably from 100 to 400 threads per square centimetre, for example about 286 threads per square centimetre.

Whilst the mono-filament linking threads in the spacer layer can be individually spaced apart and perpendicularly arranged with respect to the upper and lower surface layers, they are preferably arranged such that each pair, or group, of threads is in the form of a V-shape, when the fabric is viewed in cross-section, with the angle of the V preferably being from 5° to 55° , for example about 27° to about 32° . The V-shaped pairs or groups of threads can form a zig-zag pattern, and each individual thread can have a horizontal midsection which is inlaid into the upper surface layer.

Preferably at least 50% and more preferably 100% of the linking threads are arranged in V-shaped formations.

By arranging for pairs or groups of threads linking the upper and lower surfaces to lie at opposed angles to the perpendicular distance between the upper and lower surfaces, it is possible to improve the resistance of the spacer fabric to "flopping over" when subjected to a compressive force. This "flopping over" is highly undesirable since it can result in the complete flattening of the spacer fabric and a loss of the spacer

layer with its properties of breathability and heat dissipation. As the linking threads are angled in alternate directions the spacer fabric can achieve a comfortable resilient feel whilst still retaining
5 breathability, heat dissipation and a resistance to crushing. The inlaid midsection also helps to spread the load of the mono-filament thread on the upper surface layer.

10 The linking threads preferably have a sufficient stiffness to resist complete crushing of the fabric by the distributed weight of the baby, and yet have sufficient resilience to impart a springiness or "give" to the fabric for comfort. Preferred mono-filament yarns
15 for use as linking threads have a dTex of from 22 to 115, and can be made, for example, from a polyamide such as Nylon, a polypropylene, or most preferably, a polyester.

Preferably the spacer fabric of the invention is such
20 that the spacer layer requires a work of compression, as measured by BS 4098:1975 of at least 50 J/metre², preferably at least 60 J/metre², with a maximum of around 350J/m² and a thickness recovery of at least 50%, preferably at least 75%, and a compression recovery of at
25 least 65%, preferably at least 75%.

Preferably the spacer fabric of the invention is such that in the spacer layer the ratio of the volume of free space to the volume of linker threads is greater than 40,
30 preferably greater than 100.

In preferred embodiments of the invention, the upper surface layer has a construction wherein the mono-filament linker threads of the spacer layer are

effectively surrounded by softer multi-filament yarns in order to give a softer surface feel. This construction can be achieved, for example, using a Liba-DPL machine, and a combination of closed and open stitches relative to
5 the different yarns and threads. Preferably an open stitch is applied to the surface multi-filament yarns, and a closed stitch to the mono-filament linker threads.

Surrounding the mono-filament linker threads with multi-
10 filament yarns in the upper surface layer spreads the point of load of each mono-filament linker thread over a larger area and imparts greater resilience and improved compression anti-fatigue characteristics to the fabric.

15 In preferred spacer fabrics according to the invention the surface mesh is fully supported by the mono-filament linker threads.

The dimensionally stable lower surface layer of the
20 spacer fabric of the invention is preferably knitted with stitches having a plurality of loops, which can be achieved, for example, by using two guide bars instead of one, and using a Liba-DPLM machine. The number of stitches is reflected in the gauge of the knitting
25 machine used, and preferably the machine has a gauge of at least 16 and preferably 16, 22, 24, or 28. By "dimensionally stable" is meant that the lower surface layer retains its integrity even after washing and crumpling.

30 In certain embodiments of the invention, the lower surface of the spacer fabric is provided with a liquid impermeable layer which can be obtained, for example, by direct coating of the lower surface of the fabric with a

liquid-impermeable polymeric material, by impregnation of a liquid-impermeable polymeric material, or by transfer coating, or laminating a film of liquid-impermeable polymeric material thereto, to provide a tightly
5 adherent, liquid-impermeable, backing layer or impregnated layer.

Preferably the liquid-impermeable layer is provided by laminating a flexible backing layer of a suitable
10 polymeric material, for example a polyurethane film, to the lower surface of the fabric by means of an adhesive. The layer of polymeric material is preferably from 10 to 30 microns in thickness, and good results and good flexibility have been achieved using a 25 micron thick
15 polyurethane layer. Other polymeric film materials, such as, for example, polyethylene and polyvinylchloride may also be used in appropriate circumstances.

Where an adhesive is used for laminating, this may be
20 solvent or heat activated, or cold-cured but the amount of heat and pressure used in the lamination process must neither be sufficient to compress the resultant laminate unduly, nor to cause permanent damage thereto. Preferably the adhesive, when set, forms a flexible film
25 in order to prevent crumpling and flexing of the material without cracking of the film.

Preferably the backing layer achieves a pass as waterproof when tested in accordance with BS EN
30 20811:1992.

The backing layer is preferably such that it can be repeatedly machine washed and dried in a tumble dryer without undue shrinkage or permanent damage thereto.

The lower surface layer of the spacer fabric is preferably a multi-filament or spun-filament warp knitted fabric, and, for example, there may be used a multi-
5 filament yarn having a dTex of from 40 to 230, for example, about 78 dTEX. Polyamide or polyester yarns are examples of suitable multifilament yarns which can be used, although polyester yarns are preferred.

10 The spacer fabric as a whole should of course have a high wickability, which is defined as the ability of the fabric to conduct liquid away from the area of initial contact and form a relatively thin liquid film within the fabric structure. Wickability of the fabric as a whole
15 can be measured in accordance with TTM 1428:92 (FDC.348) by suspending test specimens from spring clips vertically over a beaker of distilled water and measuring the height to which the liquid rises in a given time. Preferably the spacer fabric is such that the wicked liquid rises to
20 a height of at least 50mm, preferably at least 100mm, when tested in both the warp and weft directions, in a time of 30 minutes. Prior to testing the specimens are conditioned for a minimum of 16 hours in a standard atmosphere of 20°C/65% Relative Humidity ± 2 .

25 A further measure of the ability of the spacer fabric to take liquid away from its surface and dissipate it through the fabric structure is a water dispersion test in which a solution containing a suitable dye is used to
30 measure the spread of liquid into and through the fabric. In this test, a measured amount of liquid (0.5ml) is applied to the fabric upper surface. The dimensions of the area stained due to the spread of liquid are measured over time. In a preferred spacer fabric in accordance

with the invention the dimensions of the spread of water containing dye are at least 5.5cm by 2.5cm and the spread of liquid reaches near equilibrium in about 15 minutes.

5 The fabric preferably has good heat dissipation, such that it can dissipate heat rapidly away from a hot body. Preferably the fabric is such that the temperature of the fabric when placed under a hot plate with an initial temperature of 34°C does not exceed 25°C and more
10 preferably 22°C after 10 minutes.

In certain preferred constructions according to the invention, where the liquid impermeable layer is not laminated to the spacer fabric, it is found that the
15 spacer fabric makes less noise when its surface is rubbed softly, thereby improving the comfort of a cot mattress produced therefrom by reducing rustling.

Also, in the preferred embodiments, improved bounce and
20 resilience of the spacer fabric can be obtained by the omission of multi-filament linker threads from the spacer layer, allowing the full properties of the monofilament threads to be utilised.

25 In one embodiment according to the present invention, a cot mattress can be formed by providing a mattress core, a mattress cover comprising a spacer fabric according to the invention, and a liquid impermeable layer therebetween. For example, a mattress core, which can be
30 either a foam plastics core or a sprung interior mattress core, can be provided with a liquid impermeable waterproof underlay, and the spacer fabric of the invention can be formed into a removable mattress cover therefor. An advantage of this construction is that the

spacer fabric without the waterproof laminated layer is likely to be more resistant to creasing and distortion when washed at high temperatures. In this embodiment the mattress core is preferably completely enclosed with
5 a waterproof film layer in order to prevent liquids from reaching the core. Complete enclosure of a foam mattress core, for example, by the use of a water proof plastics underlay, is important, since if the mattress becomes wet it can form depressions which do not recover when dry.

10

The resistance of a laminated mattress cover according to another aspect of the invention, wherein the cover comprises the spacer fabric and a waterproof plastics backing layer, to distortion and creasing during a 60°C
15 wash, may be improved by cross-linking the plastics layer, either before or after the lamination step. Cross-linking can be carried out by, for example, electron beam irradiation, chemical cross-linking, or other techniques known to the art. In this aspect of the
20 invention, cross-linking of the waterproof backing can be applied to laminated mattress covers according to the present invention, and also to the backing layer of laminated spacer materials produced in accordance with GB2305191B.

25

Preferred embodiments of spacer fabrics and mattress covers according to the present invention have improved breathability and air flow properties due to the increased ratio of hole size to strand size in the woven
30 mesh of the upper surface layer and have improved air permeability due to the increased air space of the spacer layer. An improvement in softness is also achieved by the stitching technique in which the linking mono-filaments are masked by softer multi-filament yarns to form a

softer surface.

The foam plastics core or body of the mattress preferably comprises an open cell polymeric foam material, for example, a foamed polyurethane, and very good results have been obtained using Vitafoam (RTM), a polyurethane foam comprising Melamine as a fire retardant additive. Preferably the foam plastics core or body is permeable to air, although with certain spacer materials of high breatheability this may not be essential. Perforation of the foam plastics core is not usually required.

Where the spacer fabric is used as a mattress cover or mattress protector, it is preferably removable from the mattress core or body for washing purposes and, for example, the cover material or mattress protector may be a loose cover, or provided with a zip at one or more edge regions to permit such removal.

In order to reduce the manufacturing cost of the cot mattress, it is possible to provide the spacer fabric as the top surface layer only of the mattress, the sides and lower surfaces being made of cheaper standard mattress cover fabric material.

In preferred embodiments of the invention, the mattress achieves a pass under BS Standard 7177 for Resistance to Ignition of Mattresses, Divans and Bed Bases, and BS Standard 1877 Fire Retardancy Test for Mattresses and Bumpers for Childrens' Cots, Perambulators and Similar Domestic Articles and is devoid of fire retardant additives comprising antimony, phosphorus or arsenic.

Spacer fabrics can be knitted, for example, on

Raschelmachines with two needle bars. Depending upon the nature of the spacer fabric and its physical requirements, a minimum of four guide bars, and normally four to six or more guide bars, are used. In addition to
5 the requirements set out hereto, the thickness of the yarn used for the spacer threads is influenced by the distance between the upper and lower surfaces, the desired softness of the upper surface and whether the central layer is knitted with one guide bar or with two
10 guide bars knitting in opposition to each other. The manufacturing methods for spacer fabrics are discussed in the brochure "Spacer Fabrics - Manufacturing Methods and Applications" published in 1994 by Karl Mayer Textilmaschinenfabrik GmbH, the entire disclosure of
15 which is incorporated herein by reference for all purposes. In the spacer fabrics of the present invention, the distance between the upper and lower surfaces, that is, the width of the spacer layer, is preferably from 3 to 6 mm, more preferably about 4.5 mm.

20 Preferred embodiments of a spacer fabric and a cot mattress and mattress cover according to the invention are described in the following Examples:

25 EXAMPLE 1

A spacer fabric for a material in accordance with the invention is knitted on a RD6N machine using two needle
bars and six guide bars. The sequence of operation is as
30 follows:

GUIDE BAR	5-4-4-4/2-3-3-3/5-4-4-4/3-2-2-2/0-1-1-1/ 3-2-2-2/0-1-1-1/2-3-3-3//
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GUIDE BAR 2 0-1-1-1/3-2-2-2/0-1-1-1/2-3-3-3/5-4-4-4/
 2-3-3-3/5-4-4-4/3-2-2-2//

5 GUIDE BAR 3 1-0-2-3//

GUIDE BAR 4 2-3-1-0//

GUIDE BAR 5 2-2-2-0/0-0-0-2//

10 GUIDE BAR 6 0-4-4-5/5-5-1-0//

Guide bars 1 and 2 form the top mesh surface. The guide bar movement to form the mesh may be varied to make an oval, hexagonal, diamond, square, round, rectangular etc type mesh as desired.

Guide bars 3 and 4 could have different movements for the linking threads, which could in an alternative manufacturing method use only one instead of two guide bars. It would also be possible to use two half set guide bars in opposition instead of one.

Guide bars 5 and 6 could again have different movements for the production of different fabric backing types.

The construction notation is given in steps of 2 i.e. 0-1-2-3-4, where each number represents a movement (or non-movement of the guide bar over one needle space).

30

Eg. 0-1 is a movement over one needle.
 0-2 is a movement over two needle.

The numbers between the / marks represent the

movement with respect to a needle bar or bars.

Eg. 1-0-1-2// will mean the guide bar knitting over both needle bars (to use the linking threads).

5 1-0-1-1// will mean the guide bar knitting only on one needle bed, as there is no movement (2-2) on the second needle bar.

In a preferred embodiment, by way of example only, the yarn dTEX (thickness) is as follows:

10

Bars 1 and 2 - 78 dTEX polyester

Bars 3 and 4 - 33 dTEX polyester

Bar 6 - 78 dTEX polyester

15 The resultant spacer fabric has a thickness of 4.5mm, an upper surface mesh hole average diameter of 2mm and an average mesh strand width of 2mm.

20 The spacer fabric can be slit to 60cm wide and made up into a zip-off cover for a cot mattress. The foam core of the cot mattress is a 10cm thick polyurethane foam material of grade 35M.

25 All the polyester yarns used in the manufacture of the spacer fabric exemplified, and the polyurethane foam of the mattress core, are chosen to be substantially free of arsenic and antimony, and to contain less than 12 parts per million, preferably to be substantially free, of phosphorus.

30

A spacer fabric spacer material and mattress produced as described above are subjected to the following tests, with results and conclusions as set out below:

1. Air Permeability Test

This is to assess the breathability of the fabric, i.e. the ease with which air passes through the fabric structure.

Test Method: BS 4578:1970 (1991) Measurement of Restriction of Airflow.

The fabric of the invention is compared with a control sample manufactured in accordance with GB2305191B.

The closer the result is to zero the better the airflow through the mattress cover.

The results are as follows:

	New fabric	GB2305191B
Upper fabric surface	0.3 mm H ₂ O	1.7 mm H ₂ O

The results indicate that the spacer material mattress cover of the present invention has a significantly higher permeability and thus, improved breathability.

After washing in accordance with BS49236A at 40°C and line drying, the air flow restriction of the spacer material mattress cover of the invention is still very low.

2. Liquid Dissipation Tests

These demonstrate the ability of the fabric to take liquid away from the surface and dissipate it through the fabric structure.

The tests are in three parts:

2(a) Liquid Flow Test

Liquid flow from the surface of the fabric into the structure of the fabric. Liquids with viscosities of from 27.3 to 31.5 dynes/cm are tested. (Based on Oil

Repellency Rating AATCC method).

The closer the grade is to zero, the more liquids are taken into the fabric.

Grade - less than 1 indicates that liquids of all tested viscosities soaked into the fabric structure and proves liquid would not sit on the fabric surface.

2(b). Wicking test (Based on TTM1428:92 (FDC. 348)

Test specimens are suspended over a beaker of distilled water and the height to which the liquid rises is measured over time.

The fabric is tested, and compared to a control sample of a fabric produced in accordance with GB2305191B, in both directions of the fabric.

The results are as follows:

<u>Wicking Rate</u>	<u>GB2305191B</u>	<u>New Fabric</u>
Warp direction 1 min	52.5 mm	34mm
Warp direction 5 mins	95mm	60mm
Warp direction 30 mins	Exceeds clips - 17 mins	111mm
Warp direction 1 hr	----	130mm
Weft direction 1 min	47.5mm	46mm
Weft direction 5 mins	72.5 min	65mm
Weft direction 30 mins	1 x 120mm 1 x exceeds clips - 29 mins	120mm
Weft direction 1hr	exceeds clips - 38 mins	exceeds clips

Whilst the results for the new fabric are slightly

inferior to those quoted in GB2305191B, they are comparable, especially in the weft direction, and it can be seen that the presence of wicking fibres in the surface layer substantially compensates for the increase in hole size to strand size.

2(c) Water Dispersion Test

A solution containing dye is used to measure the spread of liquid into and through the spacer fabric.

A measured amount (0.5ml) is applied to the fabric surface. The dimensions of the area stained due to the spread of liquid are measured over time.

The fabric is compared with control samples of a woven cotton mattress fabric and p.v.c.

It is found that the spread of liquid in the spacer fabric reaches near equilibrium, i.e. maximum spread, after about 15 minutes.

Both the cotton woven fabric and p.v.c. are found to have zero spread, and water therefore sits on the surface of the fabrics.

Therefore, the spacer fabric is superior in taking liquid away from the surface of the fabric and dissipating it through the fabric structure.

3. Fire Retardancy Test

The mattress is tested for fire retardancy to the standard laid down in the Furniture and Furnishing (Fire) (Safety) Regulations 1988. The result is a pass.

4. Washability Test

Washability tests are carried out. The suitable care instructions are:

- (i) wash as synthetic - maximum temperature 60°C
- (ii) no bleach
- (iii) no iron
- (iv) no dry clean

(v) tumble dry

5. Thickness Compression and Recovery Test

Five samples of the fabric of the invention are tested following the procedure described in BS4098:1975, the results averaged and compared with the results obtained in GB2305191B.

Reference	Sample (averaged)	GB230519B
Original thickness	4.1mm	3.6mm
10 Compression	3.4mm	2.6mm
Work of compression	63J/m ²	73J/m ²
Thickness recovery	82.9%	72.7%
Compression recovery	79.4%	64.7%
Work recovery	42.9%	

15

The results show that the spacer material has a lower work of compression and an improved thickness recovery and compression recovery after compression.

20 6. Heat Dissipation Test

A rectangular hot plate with an initial temperature of 33.8°C is placed on a mattress cover according to the invention and the temperature build-up of the mattress cover under the hot plate and up to 12 cms distant from the edge of the hot plate measured using two sets of five thermocouples, the individual thermocouples in each set being disposed at intervals of 4 cms apart. A 100% PVC mattress cover is used as a control. Thermocouples 1 and 25 6 are disposed under the hot plate in the central region thereof and 10cms apart. Thermocouples 2 and 7 are disposed at the edge of the hot plate. Thermocouples 3 to 5 (and 8 to 10 similarly) are disposed in a line, respectively 4cms, 8cms and 12cms from the edge of the 30

hot plate.

The results indicate that, using the mattress cover of the invention, the temperature rises more slowly, and even after 75 minutes, the temperature under the hot plate using the mattress cover of the invention is significantly lower than that of the PVC control.

EXAMPLE 2

10

A second spacer fabric for a material in accordance with the invention is knitted on a RD6N machine using two needle bars and six guide bars. The sequence of operation is as follows:

15

GUIDE BAR 1 2-0-2-2/2-4-2-2/2-0-2-2/2-4-6-6/6-8-6-6/
 6-4-6-6/6-8-6-6/6-4-2-2//

20

GUIDE BAR 2 6-8-6-6/6-4-6-6/6-8-6-6/6-4-2-2/2-0-2-2/
 2-4-2-2/2-0-2-2/2-4-6-6//

GUIDE BAR 3 8-8-4-4/2-2-4-4/8-8-4-4/0-0-4-4/6-6-4-4/0-
 0-4-4-/6-6-4-4/0-0-4-4//

25

GUIDE BAR 4 0-2/4-6/8-10/4-6//

GUIDE BAR 5 0-0-0-2/4-4-2-0//

GUIDE BAR 6 2-2-6-8/6-6-2-0//.

30

The construction notation is given in steps of 2 i.e. 0-2-4-6-8, where each number represents a movement (or non-movement of the guide bar over one needle space).

In a preferred embodiment, the yarn dTEX (thickness) is as follows:

Bars 1 and 2 - 55 dTEX polyester

5 Bars 3 and 4 - 69 dTEX polyester

Bar 5 & 6 - 50 dTEX polyester

10 An embodiment of a spacer material according to the invention is illustrated in the accompanying Drawings in which:

Figure 1 shows the upper surface of a portion of the spacer material in plan view; and

15 Figure 2 shows a sectional side elevation of the spacer material of Figure 1.

Referring to the Drawings, the spacer fabric illustrated generally at 1 has an upper surface 2 comprising a warp knitted multifilament mesh having strands 3 of width 2mm with holes 4 of diameter 2mm. In
20 Figure 2, there is also shown the spacer layer 5, having monofilament polyester spacer threads 6, disposed in generally V-shaped groups 7, with an acute angle α , as illustrated, between threads of opposed inclination. The
25 lower surface 8 of the spacer fabric 1 is knitted from multifilament polyester threads to form a substantially dimensionally stable layer. Individual spacer linking threads such as 9, illustrated as a thicker line, have sections 10,11, angled in opposed directions, and a
30 horizontal midsection 12 which is inlaid in the upper surface layer 2.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous

to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

5

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. A flexible spacer fabric, the fabric having a liquid permeable and breathable upper surface layer, the upper surface layer comprising a knitted mesh wherein the ratio of average hole diameter to average strand width is from 4:1 to 1:2, a heat and liquid dissipating spacer layer, and a dimensionally stable lower surface layer.
2. A fabric according to Claim 1 wherein the upper surface layer comprises a warp knitted mesh of synthetic fibres.
3. A fabric according to Claim 2, wherein the knitted mesh comprises hexagonal holes.
4. A fabric according to Claim 2 or 3 wherein the mesh average hole diameter is from 1 to 3mm.
5. A fabric according to any of Claims 2 to 4, wherein the average width of the mesh strands in the upper surface layer is from 0.5 to 3mm.
6. A fabric according to any of Claims 2 to 5, wherein the ratio of the average hole diameter to the average width of the mesh strands in the upper surface layer is from 3:1 to 1:2.
7. A fabric according to any of the preceding claims, wherein the upper surface layer is knitted from multifilament synthetic yarns.
8. A fabric according to Claim 7 wherein the

multifilament synthetic yarn is a polyester.

- 5
9. A fabric according to Claim 7 or 8, wherein the multifilament yarn has a dTEX of from 40 to 180.
10. A fabric according to any of the preceding claims, wherein the upper surface layer is such that liquids of viscosity of at least 30 dynes per cm can pass through the upper surface and into the spacer layer without lying on the surface.
- 10
11. A fabric according to any of the preceding claims, wherein the upper surface of the fabric has a grade of less than 1 when tested in accordance with the Oil Repellency Rating AATTC Method.
- 15
12. A fabric according to any of the preceding claims, which has a value of less than 2.0mm H₂O of water, when tested in accordance with BS4578:1970.
- 20
13. A fabric according to any of the preceding claims, wherein the upper surface layer comprising wicking fibres or a wicking fibre construction
- 25
14. A fabric according to Claim 13, wherein the wicking fibres comprise multifilament synthetic fibre yarns.
- 30
15. A fabric according to Claim 13 or 14, wherein the multifilament wicking fibre yarns have a dTEX of

from 40 to 180.

16. A fabric according to Claim 13, wherein the wicking fibre construction comprises an upper layer of a coarse multifilament yarn having a filament dTEX of from 6 to 3 and a lower layer of a micro filament yarn having a dTEX of from 1.1 to 0.3.
- 10 17. A fabric according to any of the preceding claims, in which the spacer layer comprises linking threads of a monofilament yarn.
- 15 18. A fabric according to claim 17, wherein the number of monofilament linking threads in the spacer layer is from 100 to 400 threads per square cm.
- 20 19. A fabric according to claim 17 or 18, wherein the monofilament threads are arranged such that each pair, or group, of threads is in the form of a V-shape.
- 25 20. A fabric according to claim 19, wherein the angle of the V is from 5° to 55° .
- 30 21. A fabric according to claim 19 or 20, wherein substantially a 100% of the linking threads are arranged in V-shaped formations.
22. A fabric according to any of claims 17 to 21, wherein the monofilament linking threads have a dTex of from 22 to 115.

23. A fabric according to any of claims 17 to 22,
wherein the monofilament linking threads comprise a
polyester.
- 5 24. A fabric according to any of the preceding claims,
such that the spacer layer requires a work of
compression as measured by BS4098:1975 of at least
60 J/m².
- 10 25. A fabric according to any of the preceding claims,
which has a thickness recovery of at least 75%.
26. A fabric according to any of the preceding to any of
the preceding claims, which has a compression
15 recovery of at least 75%.
27. A fabric according to any of the preceding claims,
such that in the spacer layer the ratio of the
volume of free space to the volume of linking
20 threads is greater than 100.
28. A fabric according to any of the preceding claims,
wherein the dimensionally stable lower surface layer
is knitted with stitches having a plurality of
25 loops.
29. A fabric according to any of the preceding claims,
wherein the lower surface layer comprises a multi
filament or spun-filament warp knitted fabric.
- 30 30. A fabric according to claim 29, wherein there is
used a multi filament yarn having a dTex of from 40
to 230.

31. A fabric according to claim 29 or 30, wherein the multi filament yarn comprises a polyester.
32. A fabric according to any of the preceding claims, which when subjected to a wickability test as hereinbefore defined is such that the wick liquid rises to a height of at least 100mm, when tested in both the warp and weft directions, in a time of 30 minutes.
33. A fabric according to any of claims 1 to 32 substantially as described in the example.
34. A mattress cover material which comprises a flexible spacer fabric according to any of claims 1 to 33 and a liquid permeable lower surface layer.
35. A mattress according to claim 34, wherein the liquid permeable lower surface layer is laminated to the spacer fabric.
36. A mattress cover substantially as hereinbefore described.
37. A cot mattress comprising a foam plastics core or a spring mattress core and a cover comprising a flexible spacer fabric according to any of claims 1 to 33 and a liquid impermeable lower surface layer.
38. A cot mattress according to claim 37, which is provided with a liquid impermeable waterproof underlay and the spacer fabric is formed into a removeable mattress cover therefore.

39. A cot mattress according to claim 37 or 38, wherein the mattress core comprises an open cell polymeric foam material.
- 5 40. A cot mattress as substantially as hereinbefore described.
41. A flexible spacer fabric substantially as hereinbefore described with reference to and as
10 illustrated in the accompanying drawings.
42. A novel spacer fabric substantially as hereinbefore described.



Application No: GB 0019130.4
Claims searched: 1-42

Examiner: Alex Littlejohn
Date of search: 7 November 2000

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
 UK Cl (Ed.R): A4S; D1K
 Int Cl (Ed.7): A47C; A61F; A61G; B32B; D03D; D04B
 Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X, Y	GB 2305191 A	(Mothercare) see whole document, e.. Page 5 lines 1-6	X:1-12, 17-32,34, 35,37-39 Y:13-16
X, Y	GB 2299814 A	(Mothercare) see whole document, e.g. page 4 line 25 - page 5 line 4	X:1-12, 17-32,34, 35,37-39 Y:13-16
Y	GB 2042003 A	(Eiser) see e.g. page 1 lines 117-130	13-16
X, Y	WO 99/05990 A1	(Sofradim) see whole document, e.g. Figs 1-3	X:1-12, 17-32,34, 35,37-39 Y:13-16
X, Y	WO 96/01602 A1	(Hoorens) see whole document, e.g. page 4 lines 33-35	X:1-32 Y:13-16
Y	WO 95/16416 A1	(Seton) see e.g. page 2 line 22 - page 3 line 9	13-16
X, Y	US 5896758	(Rock) see whole douemnt	X:1,2, 4-12, 17-32,34, Y:13-16

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.



INVESTOR IN PEOPLE

Application No: GB 0019130.4
Claims searched: 1-42

Examiner: Alex Littlejohn
Date of search: 7 November 2000

Category	Identity of document and relevant passage	Relevant to claims
X	US 5834382 (Frebourg) see whole document, e.g. claim 1 and col 7 lines 18-23	1-9

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.